TEMASEK JUNIOR COLLEGE
Preliminary Examinations
Higher 2

CANDIDATE NAME	
CIVICS GROUP	/

CHEMISTRY **9746/02**

Paper 2 Structured Questions **28 September 2009**
1 hour 30 minutes

Candidates answer on the Question Paper.
Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your Civics Group and candidate name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

You are reminded of the need for good English and clear presentation in your answers.
You may lose marks if you do not use appropriate units.
A Data Booklet is provided.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
Total	

Answer **all** questions in the spaces provided.

For Examiner's Use

1 This question is about chlorine and its compounds.

(a) A teacher instructed a student to react some chlorine gas with 250 cm^3 of 0.100 mol dm^{-3} aqueous sodium hydroxide, and left the lab. After he returned, he realized that he had not specified the reaction temperature. The teacher found that the pH of the solution had become 12.0. After acidifying the solution and adding excess silver nitrate, 2.69 g of silver chloride was obtained. He then concluded that the student had heated the sodium hydroxide.

For this question, you may assume that all of the chloride ions are precipitated by the addition of silver ions.

(i) Determine how the teacher arrived at his conclusion.

(ii) If the student had not heated the aqueous sodium hydroxide and the same amount of chlorine gas was used, what would be the resulting mass of silver chloride obtained when excess silver nitrate is added after acidifying the solution?

[5]

[Turn over]

For Examiner's Use

(b) The melting point of $POCl_3$ is 1.25 ^oC whereas the melting point of PCl_5 is 166.8 ^oC.

(i) Name and draw diagrams to illustrate the shapes of $POCl_3$ and PCl_5.

(ii) Explain, in terms of structure and bonding, why PCl_5 has a higher melting point.

[4]

[Turn over]

For Examiner's Use

(c) Phosphorous pentachloride is commonly used in organic reactions such as the following:

$$CH_3OH(l) + PCl_5(s) \longrightarrow CH_3Cl(g) + POCl_3(l) + HCl(g)$$

(i) With reference to the *Data Booklet* and the following bond enthalpies, calculate the enthalpy change of the above reaction.

Bond	**Bond Energy / kJ mol^{-1}**
P=O	460
P-C*l*	331

(ii) Deduce whether the entropy change is positive or negative and hence explain why the above reaction occurs at room temperature.

For Examiner's Use

(iii) Given that the actual standard enthalpy change of reaction is -104.3 kJ mol^{-1}, suggest *two* reasons for the discrepancy.

[7]

(d) A student mixed up three test tubes containing chlorobenzene, trichloromethane and ethanoyl chloride separately.

(i) Describe a chemical test to first identify ethanoyl chloride from among the three test tubes.

[Turn over]

(ii) Describe a second chemical test to then identify trichloromethane from among the remaining two test tubes.

For Examiner's Use

[4]

[Total: 20 marks]

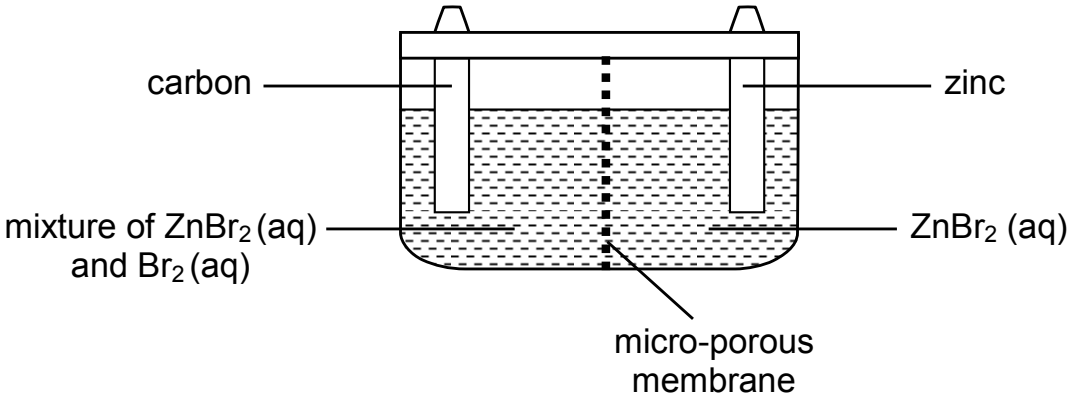
[Turn over]

For Examiner's Use

2 *The use of the Data Booklet is required for this question.*

(a) Bromine is the only liquid non-metallic element at room temperature. It reacts vigorously with metals, especially in the presence of water, as well as most organic compounds, especially upon illumination.

Bromine is also used in the zinc-bromine flow battery which is a rechargeable battery. The two electrode chambers are separated by a micro-porous membrane which prevents bromine from reaching the zinc electrode where it would react with zinc, causing the battery to self-discharge. During the charging of the battery, bromide is converted to bromine.



(i) In the table below, indicate the polarity (+/–) of the electrodes and write the half-equations for the electrode processes that occur when the battery discharges.

Electrode	Polarity	Half-equation
Zinc		
Carbon		

For Examiner's Use

(ii) 4.2 g of bromine is formed in the cell when a current of 2.0 A is passed through it during charging. Determine the length of time required to form 4.2 g of bromine.

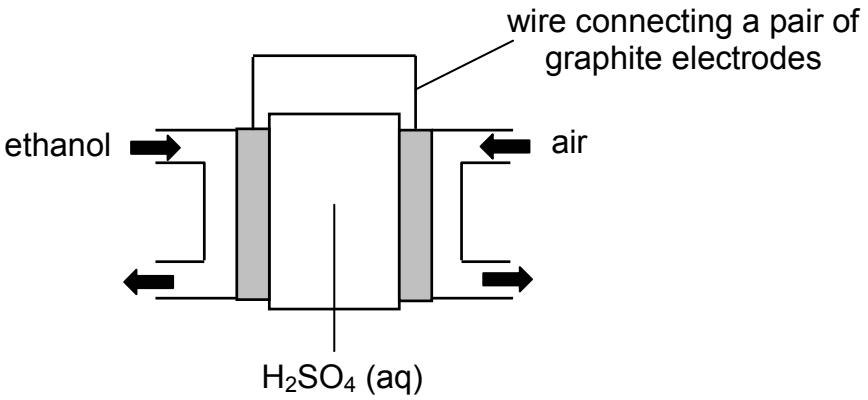
(iii) In a research laboratory, a research worker first charged a zinc-bromine battery fully before adding 10 cm^3 of 0.2 mol dm^{-3} sodium bromide solution to each of the two electrode chambers.

What is the effect on the electrical output of the battery when it is discharged?

[8]

For Examiner's Use

(b) Ethanol fuel cells are more practical than hydrogen fuel cells since ethanol is easier to store and transport than hydrogen. Ethanol is oxidised into carbon dioxide and water when the fuel cell is operated.



(i) Write the half-equations taking place at each of the electrode:

Anode: _____

Cathode: _____

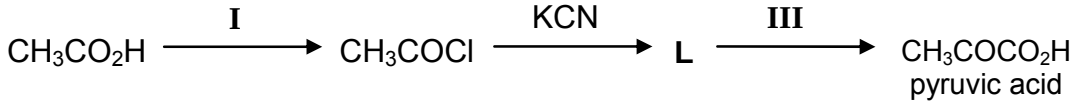
(ii) Use appropriate data from the *Data Booklet* to explain why an acidic electrolyte is often preferred to an alkaline or neutral electrolyte.

[4]

[Turn over]

For Examiner's Use

(c) Ethanol can be oxidised to form ethanoic acid, which is used to prepare pyruvic acid, CH_3COCO_2H in a 3-step synthesis.



(i) State the reagents and conditions for stages **I** and **III**.

Stage I: _____

Stage III: _____

(ii) Identify the intermediate compound, **L**.

[3]

[Total: 15 marks]

[Turn over]

For Examiner's Use

3 The first six ionisation energies of three successive elements in a Periodic Table are given below:

	Ionisation energy in kJ mol^{-1}					
Element	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**
A	786	1580	3230	4360	16100	19800
B	1060	1900	2920	4960	6270	21300
C	1000	2260	3390	4540	7000	8500

(a) State and explain the group of the Periodic Table which element **B** belongs to.

[2]

(b) Explain why the first ionisation energy of **B** is higher than the first ionisation energies of **A** and **C**.

[Turn over]

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[3]

[Total: 5 marks]

4 Tertiary structure refers to the complete three-dimensional structure of the polypeptide units of a given protein. Included in this description is the spatial relationship of different secondary structures to one another within a polypeptide chain and how these secondary structures themselves fold into the three-dimensional form of the protein. Secondary structures of proteins often constitute distinct domains. The secondary protein structure is the specific geometric shape caused by intramolecular and intermolecular bonding of amide groups.

(a) Draw a diagram showing **three** strands of an anti-parallel β-pleated sheet structure of a protein. On the diagram, indicate the type of intermolecular force that holds the protein chains together.

[2]

For Examiner's Use

(b) When a protein is denatured, the tertiary structure is disrupted. Explain in chemical terms how R group interactions are broken in each of the following situations. In your answer, identify the type of R group interaction which is broken for each example.
[R group = alkyl group]

(i) In the presence of metal ions, e.g. Ag^+.

(ii) At pH 2.

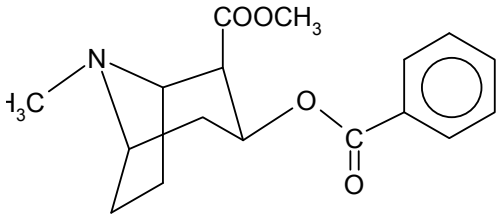
[4]

[Total: 6 marks]

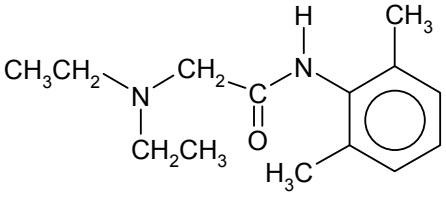
[Turn over]

For Examiner's Use

5 (a) Cocaine is commonly used in drug abuse but medicinally, it is valued as a local anaesthetic. Synthetic drugs developed from cocaine have been introduced to provide safer, less toxic local anaesthetic action. One of them is lignocaine which is currently the most widely used anaesthetic, having rapid action, effective absorption and good stability.



cocaine



lignocaine

(i) Identify the functional groups that are present in lignocaine.

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(ii) Label all the chiral centres in the two molecules above with asterisk (*).

(iii) When lignocaine is boiled with aqueous sodium hydroxide, two compounds, **X** and **Y**, are formed. **X** is soluble in aqueous sodium hydroxide while **Y** is immiscible with aqueous sodium hydroxide.

Identify the structural formula of **X** and **Y**.

X	**Y**

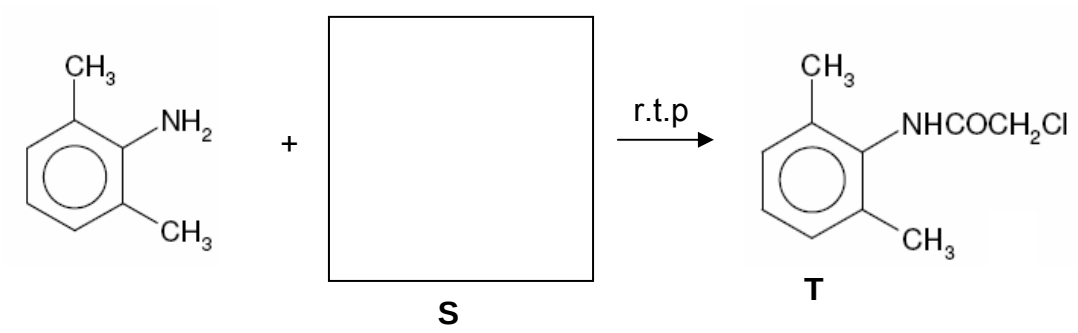
[Turn over]

For Examiner's Use

(iv) Explain why **X** is soluble in aqueous sodium hydroxide while **Y** is immiscible with aqueous sodium hydroxide.

[8]

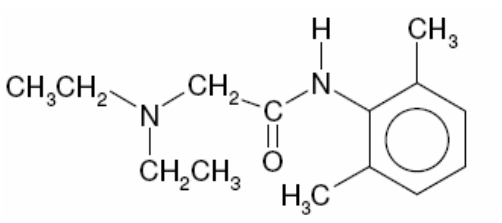
(b) Using simple molecules like 2,6-dimethylphenylamine, ammonia and chloroethane, lignocaine can be synthesised as shown below.



S **T**

$NH_3 + CH_3CH_2Cl$ —(heat in sealed tube)→ **U**

T + U ⟶ **lignocaine**



For Examiner's Use

(i) Draw the displayed structural formulae of the starting material, **S** and the intermediate, **U** in the boxes above.

(ii) What problem do you foresee in the synthesis of intermediate **U**? Explain briefly.

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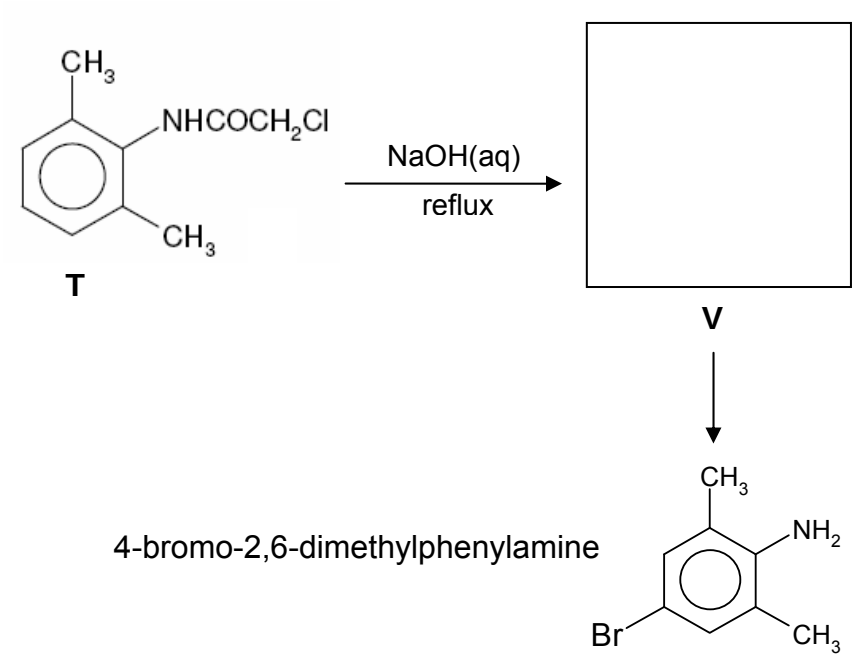
(iii) **T** can be used as a starting material to synthesise 4-bromo-2,6-dimethylphenylamine via the following route:



In the box above, draw the structure of **V**.

(iv) State the reagent and condition to convert **V** to 4-bromo-2,6-dimethylphenylamine.

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[6]

[Total: 14 marks]

[End of Paper]

For Examiner's Use

[End of Paper]